

Potential French Participation to AFTA-C

A. Boccaletti, P. Baudoz, R. Galicher, F. Martinache

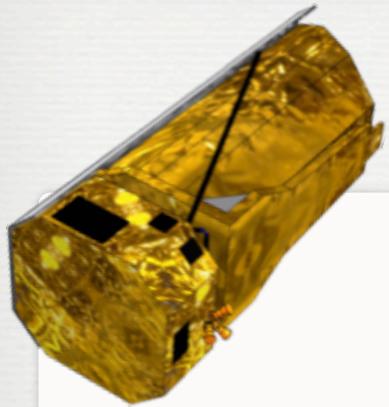
EXPERTISES

■ ACTIVITIES in PARIS OBSERVATORY

- coronagraphy (VLT/SPHERE, JWST/MIRI)
- high order wavefront control (Self Coherent Camera)
- simulations and science definition

■ ACTIVITIES in NICE OBSERVATORY

- coronagraphy (SCExAO, E-ELT/SPEED)
- wavefront sensing (CLOWFS, on sky speckle nulling)
- postprocessing (kernel phase)



SPICES PROPOSALS

Proposed to
ESA in 2010

Spectro-Polarimetric Imaging and Characterization of Exoplanetary Systems

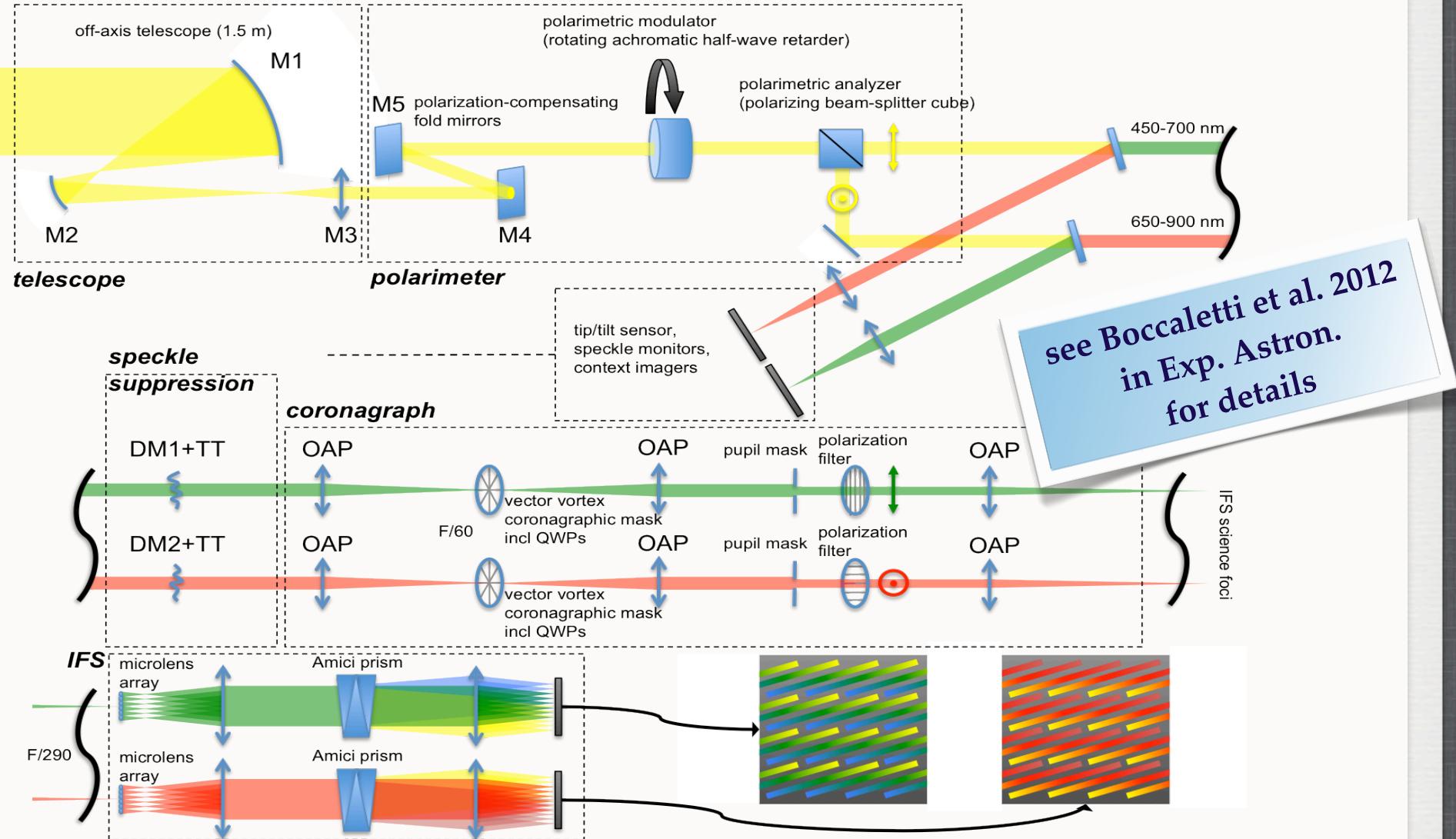
1 objective : Study planetary systems as a whole

- 1. characterization of known mature giants planets to Super Earths**
- 2. characterization of known young giants planets + new detections**
- 3. characterization of known disks) + new detections**

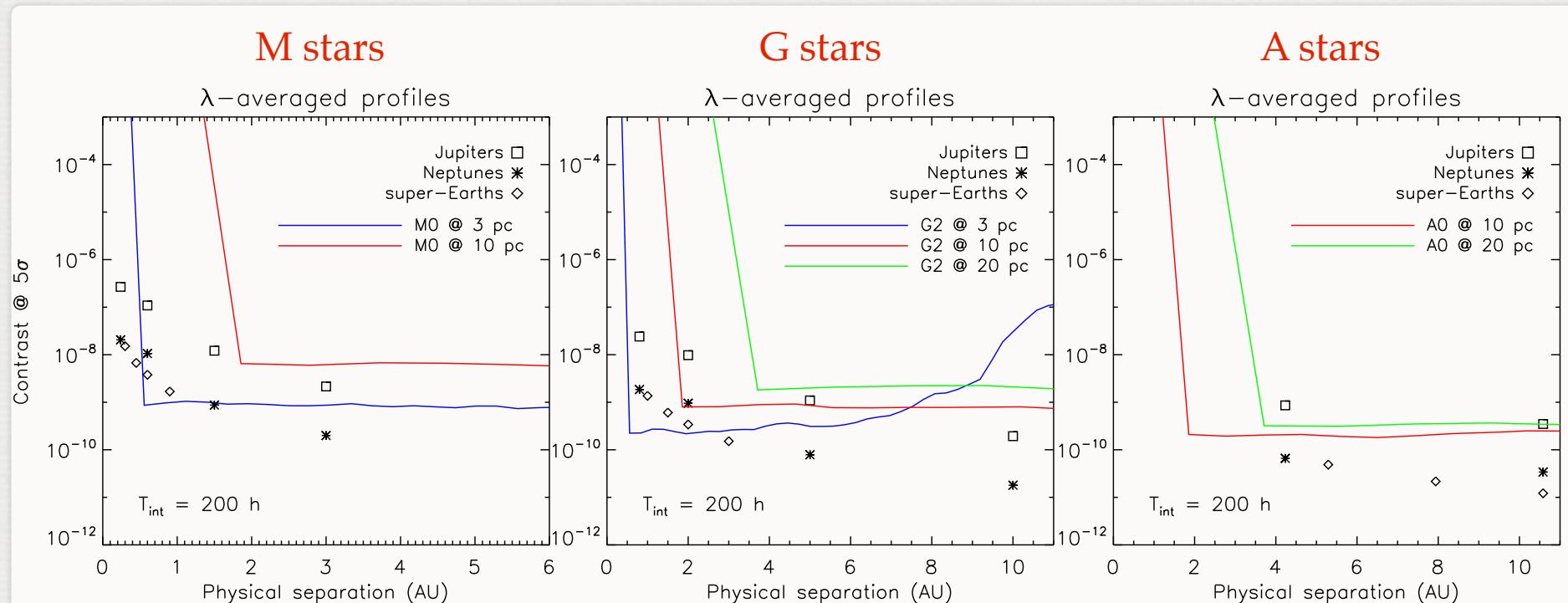
Boccaletti et al. 2012 : conceptual design

Maire et al. 2012 : simulations

SPICES DESIGN



PERFORMANCE - DETECTION



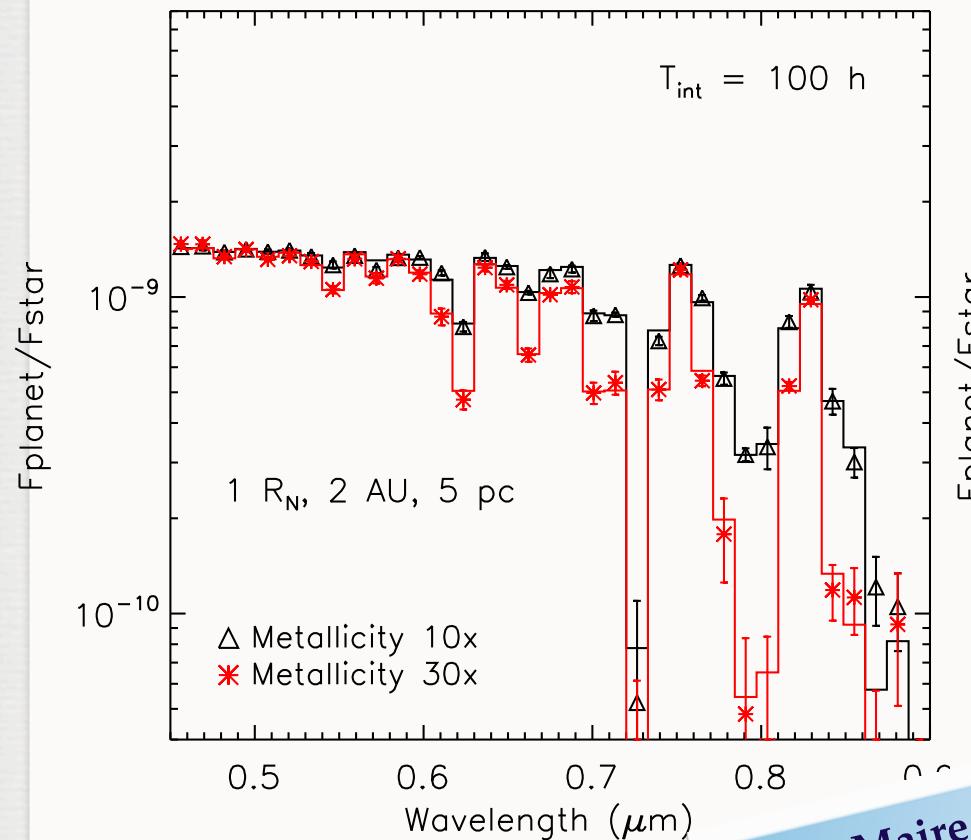
	limit in separation [AU]		
	Jupiter	Neptune	Super Earth
$A0 < 20$ pc	1 - 10	1 - 3	1 - 3
$G2 < 10$ pc	1 - 6	1 - 3	1 - 2
$M0 < 7.5$ pc	0.5 - 4	0.5 - 1.5	0.5 - 1

possibly
habitable planets

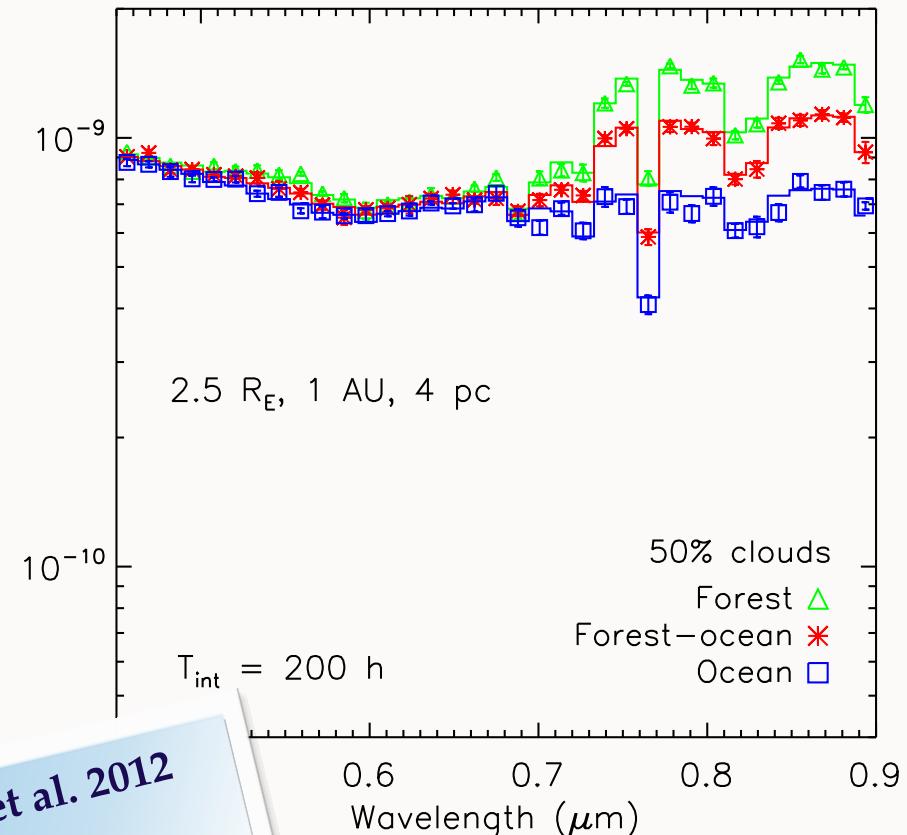


SPECTROSCOPY - GIANTS/TELLURIC

Neptune (metallicity)

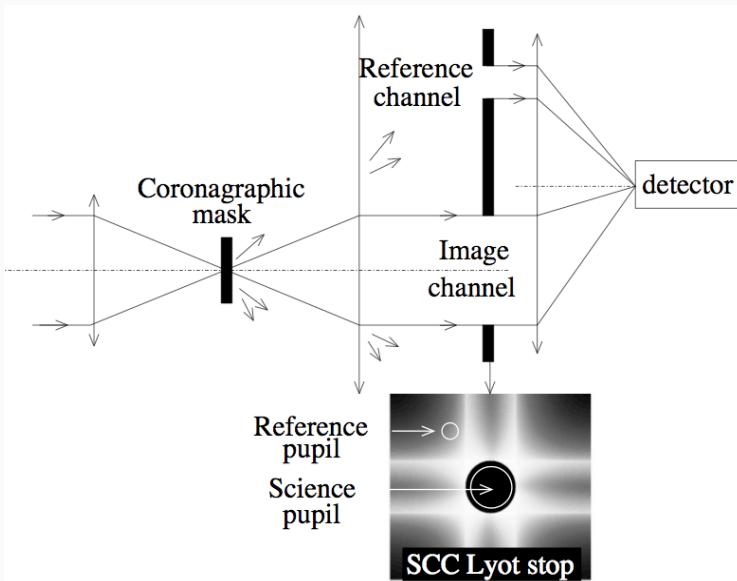


Telluric (50% clouds)

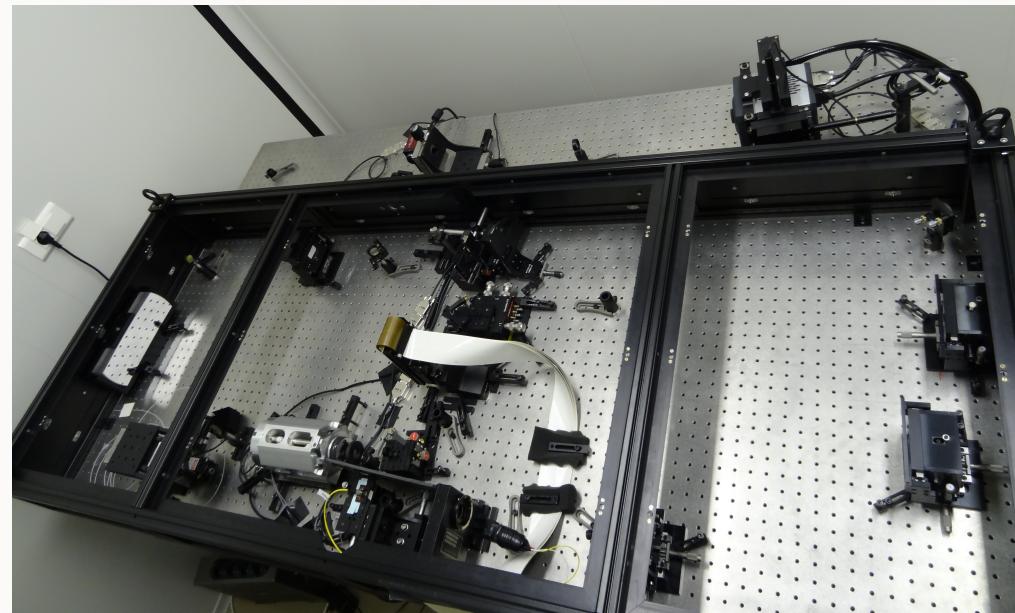


THD BENCH: A UNIQUE BENCH

- Electric Field measurements with spatial modulation (Self Coherent Camera) => unique expertise
- Large spectral bandwidths available (250 nm)
- Tip-tilt control (Mas et al. 2012, Singh et al. 2014)
- Not in vacuum !

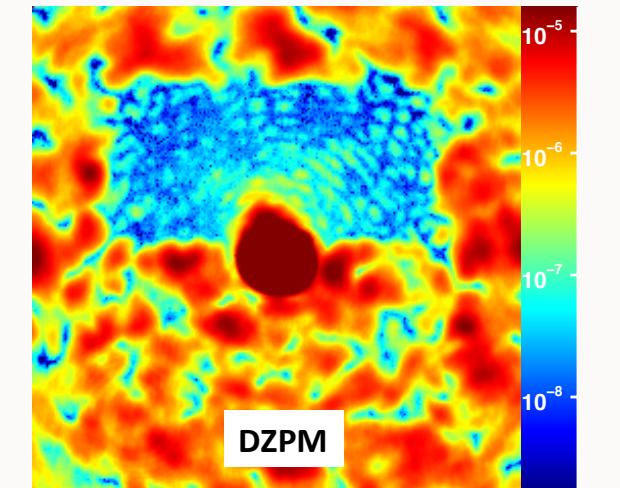
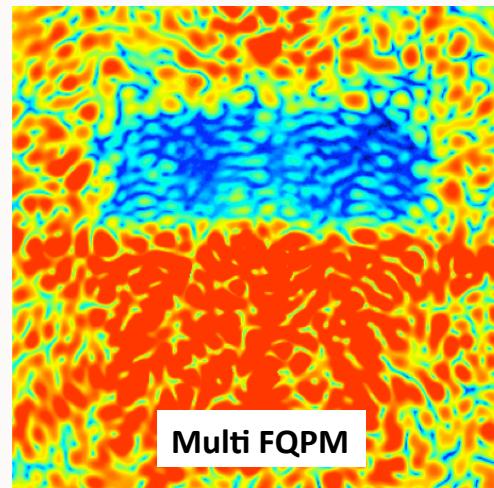
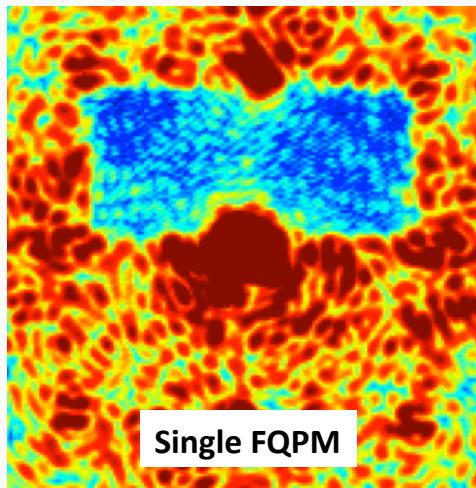


Concept of Self-Coherent Camera used on the THD bench



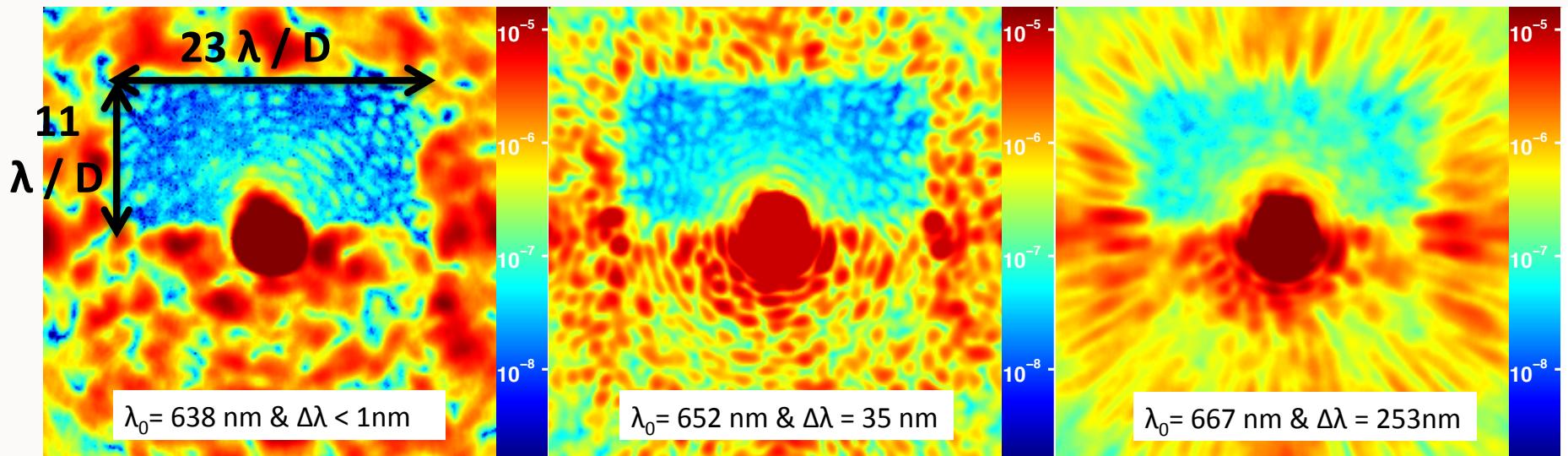
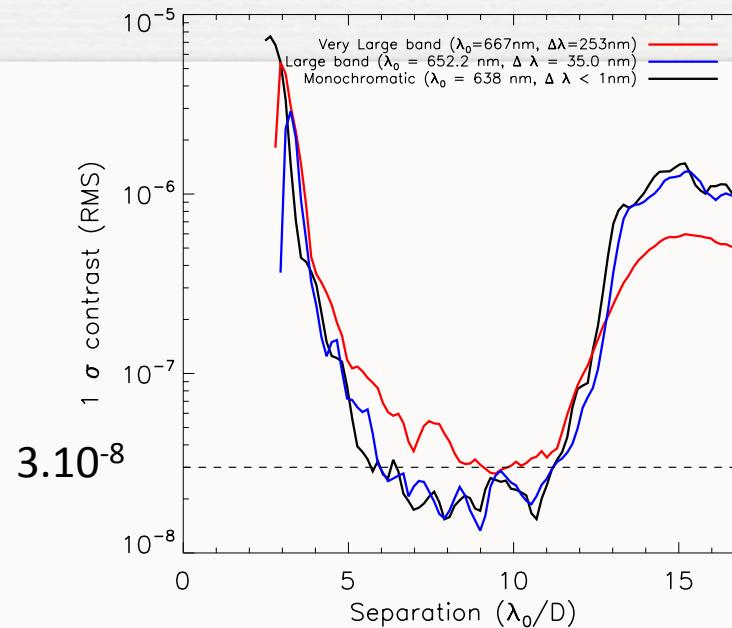
THD BENCH: A UNIQUE BENCH

- **Ready to use** with most of the coronagraphs (FQPM, M-FQPM, DZPM already tested, 8-QPM, Vortex in progress)
- Soon **3 DMs for amplitude correction** (upgrade under development)
- **Collaboration with several groups**
 - Test of **new coronagraphs** (France, Japan)
 - Comparison **spatial vs time modulation** (France)
- Strong **CNES support** (R&T funds since 2010)



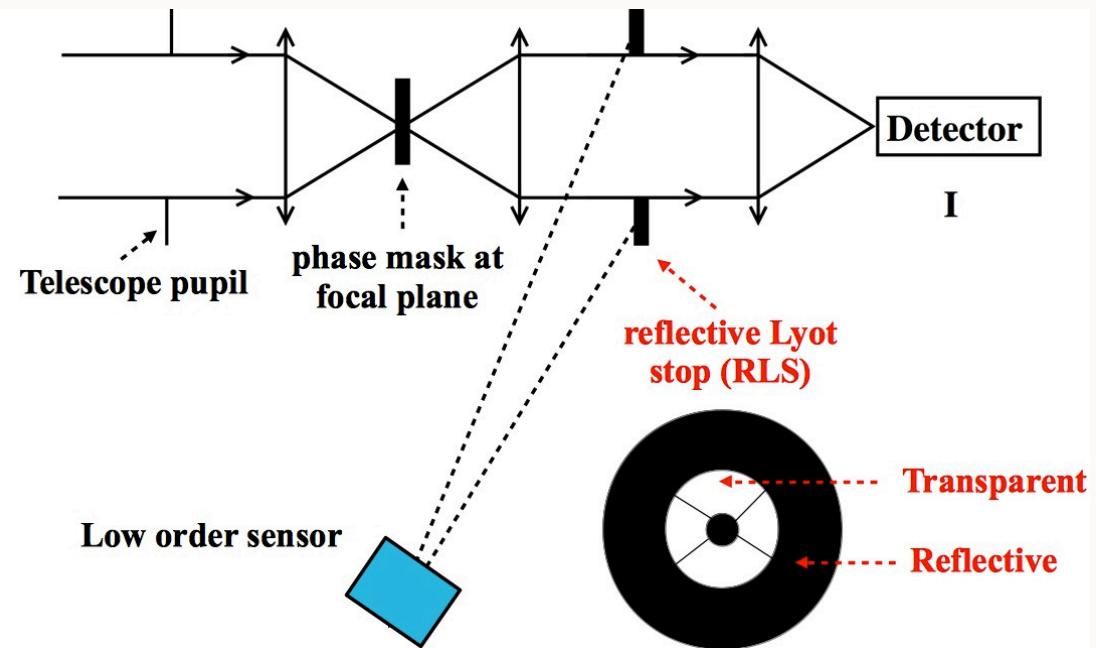
PERFORMANCE WITH DZPM

Achromatic bench at 10^{-8} level



CLOWFS

- uses the light otherwise discarded by the coronagraph
- uses the diversity introduced by the focal plane mask



Guyon et al, 2009, ApJ, 693, 75
Singh et al, 2014, PASP, 126, 586

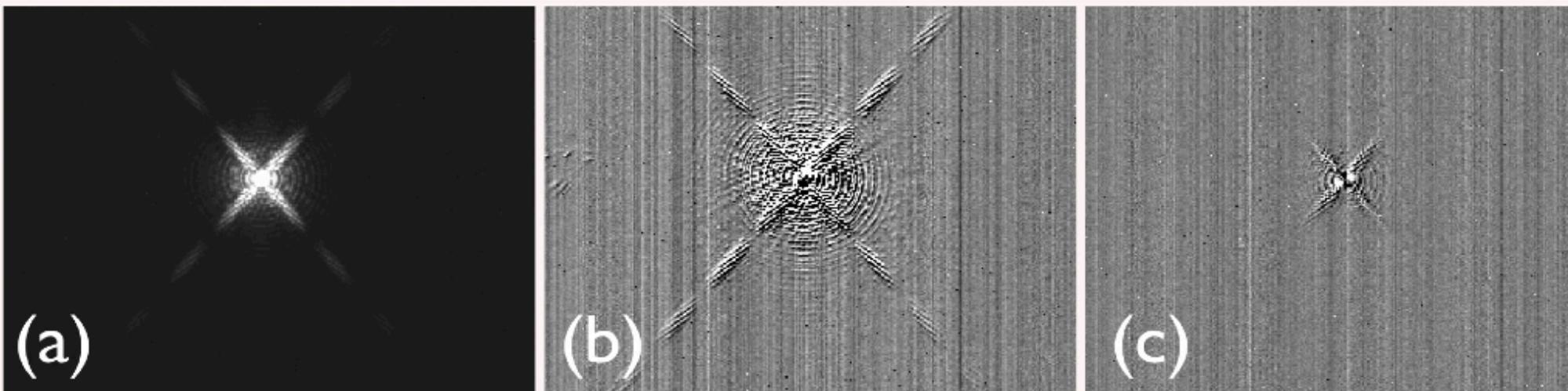
CLOWFS

Close-loop CLOWFS demonstrated:

- tip-tilt stability $1\text{e-}3 \text{ I/D}$
- pointing calibration $1\text{e-}4 \text{ I/D}$

TDEM PIAA Milestone #2 (2012)

Also used during on-sky at the Subaru Telescope

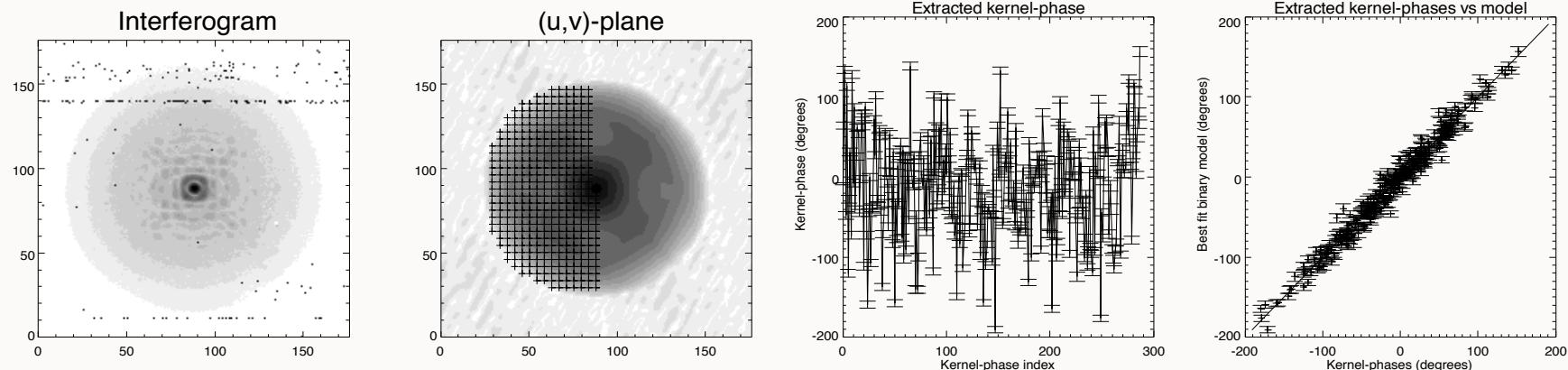


Post-processing sensitivity enhancement demonstrated:
use CLOWFS telemetry to predict/calibrate coronagraphic leaks in the science image

Vogt et al, 2011, PASP, 123, 1434

SUPER RESOLUTION IMAGING WITH KERNEL PHASE

- Post-processing technique using an interferometric point of view
- Analysis of non-coronagraphic images for moderate ($10^3 - 10^4$) contrast detection in the super-resolution regime ($< 1 \lambda/D$)
- Successfully applied to HST archive data and AO-corrected data (PALM3000)



Martinache, 2010, ApJ, 724, 464
Pope et al, 2013, ApJ, 767, 110

IDEAS FOR POTENTIAL CONTRIBUTIONS...

- hardware participation on instrument/platform? not clear to us yet.
- Apply Maire et al. analysis with AFTA-C characteristics
- participate to the conceptual design of the coronagraphic channel + sensitivity analysis to define requirements
- participate to design/manufacturing of CLOWFS + postprocessing
- participate to data reduction (kernel phase)
- SCC bench (Paris) could be available for testing some components
- Marseille: low order active mirror + coronagraphy
- First light imaging (Grenoble/Marseille): contract with JPL (advise on EMCCD). Can be involved in detector electronics/characterization

IDEAS FOR POTENTIAL CONTRIBUTIONS...

- other european partners were involved in SPICES: high contrast IFS (Italy), polarimetry (NL)
- CNES is already funding us for SCC R&D and collaborations
- CNES supports a potential contribution (small) to WFIRST AFTA
- Airbus Defence & Space (ex. Astrium) also have supported SPICES and phD funding for SCC (J. Mazoyer)

All these proposals rely on the workload of each partner and is subject to modification